On the role of ^{210}Bi on the apparent disequilibrium of ^{210}Pb-^{210}Po pair in the sea

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The ^{210}Po ($t_{1/2 = 138\ days}$) - ^{210}Pb ($t_{1/2 = 22.3\ years}$) pair as well as that in ^{238}U -^{234}Th pair has been used for estimating export fluxes of particulate organic carbon in the ocean. However, the role of ^{210}Bi has not drawn sufficient attention in the ^{210}Pb-^{210}Po disequilibrium studies although ^{210}Bi as an intermediate decay product of ^{210}Po and substantially long half-life (5.01 days) to participate in the particle processes occurring in the sea, partly due to its short half-life to determine *in situ* concentration aboard the ship. Most current studies assume that ^{210}Bi is not particle reactive but conservative. However, it is known that ^{210}Bi is more enriched in particulate matter than ^{210}Po and ^{210}Pb as much as an order of magnitude. This indicates that the deficiency of ^{210}Po to ^{210}Pb activities (A_{Pb}^{t} - A_{Po}^{t}) in the surface ocean may include the deficiency of ^{210}Bi to ^{210}Pb (A_{Pb}^{t} - A_{Bi}^{t}) resulting from sinking of ^{210}Bi attached to the particle in the ocean. We developed a model to elucidate a role of ^{210}Bi in the behavior of ^{210}Po-^{210}Pb pair in the ocean. We assumed that the activities in the dissolved and particulate phases of ^{210}Pb, ^{210}Bi and ^{210}Po in a given water column are determined by the concentration of particle in water column, input and output, distribution coefficients between dissolved and particulate phases, decay constants of these radionuclides. We estimated the ^{210}Bi contribution to the ^{210}Pb-^{210}Po activity difference in seawater (A_{Pb}^{t} - A_{Bi}^{t})/(A_{Pb}^{t} - A_{Po}^{t}) as much as 78% and the ^{210}Bi decay-corrected *in-situ* ^{210}Po activity in stored seawater samples was different as much as 30%. These results show that ^{210}Bi is very important to determine the behavior of ^{210}Po-^{210}Pb pair disequilibrium at sea.